

# Framing Camera Sensitivities

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# Framing Camera with CCD Status Update, NOV 2016

## Available GXD Framing Cameras at NIF

C C D	Camera	# strips	DIM	Add'l INFO	Gain Rel <sup>2</sup>	Pulse Vel (mm/ns)	Gate width (ps)@(bias V)	Actual Interstrip Timing
	RGXD1F	4	00-00		31	150	104 (150V)	
	RGXD2T	2	90-78 & 90-315	ERASER <sup>1</sup>	.4	131	110(100V) 106(150V)	0/97 0/206 0/252
	GXD3F & RGXD3F	4	90-78		5	142	115 (50V) 90 (300V)	
	RGXD4F-200	4	0-0 & 90-78	200 ps electrical	11	137	100 (100V)	
	RGXD4F-600 extended integration	4	0-0 & 90-78	600 ps electrical	176 (16x of -200 config)	139	228 (100V)	

RGXD4 - Door Added to allow Pulse Forming modules to be changed in field in R configuration

1 **E**arly **R**adiation **A**rtifact **S**uppression **E**lectrode **R**ig, see slide 4

2 Relative gains are extrapolated to 100V and compared to HGXD1 strip2

with average CCD counts/ CCD pixel compared to PDS film exposure counts / scan pixels

*J.P. Holder, L. R. Benedetti & the framing camera team*

# Current HGXD's

	Camera <sup>3</sup>	# Strips	DIM	Add'l INFO	Gain Rel <sup>2</sup>	Pulse Vel (mm/ns)	Gate width (ps)@(bias V)	Actual Interstrip Timing
F I L M	HGXD1T	2	0-0& 90-78	ERASER <sup>1</sup> reduced phosphor <sup>4</sup> <b>1800V</b>	0.8*	154	106 (50V) 95 (150V)	
	HGXD2F <sup>c</sup>	4	90-78	ERASER; New head & PFM design; phosphor at 1800V setting	2	132	~92(50V)/ ~82(200V)	0/250/514/743@ 200V
	HGXD3T <sup>a</sup>	2	TBD	ERASER Run w/ phosphor at 1800V setting	~0.8	137	~105(50V) 94(150V)	0/248
	HGXD6F <sup>b</sup>	4	90-78	ERASER; New head & PFM design; phosphor at 1800V setting	2	135	~80(50V)/ ~72(250V)	

a) HGXD3T pulser replaced (March 2015), Head(MCP/Phosphor) and PFMs nominally the same. Timing expected to change (next use unscheduled, expect  $\pm 200$  ps certainty). Similar sensitivity to previous build expected.

b) HGXD6F is four strip framing camera first used in April using new taper transformer drive head design

c) HGXD2F was rebuilt Aug 2015 to be like HGXD6, new MCP, **new timings and sensitivity**

1 **E**arly **R**adiation **A**rtifact **S**uppression **E**lectrode **R**ig, see slide 4

2 Relative gains/sensitivity are extrapolated to 100V and compared to HGXD1T strip2 **with 2300V** phosphor setting

3 All HGXD's are "R" or "vertical" orientation for film recovery

- \*Strip 1 on HGXD1T 20-30% less sensitive than Strip2(check flat field for specific delays/bias)

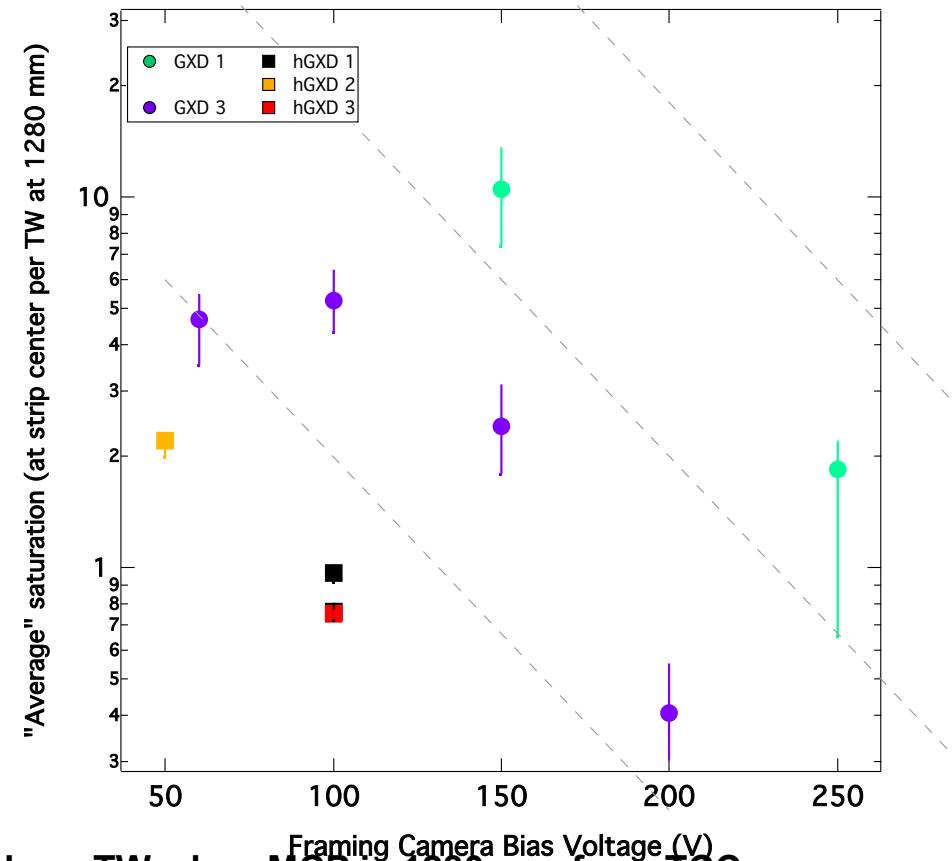
4. Engineering decision, Aug 2015, to reduce phosphor pulser charge voltage to 1800V *on all HGXD's* (~7kV to imager)

HGXD4 and HGXD5 for pulsers currently being rebuilt

# Relative Gain & Saturation Values

Average Relative saturation(%) measured on Flat field Shots

Camera	Rel. Saturation Factor (@100V)	Expected saturation value
rGXD 1F	31	10000
GXD 3F	5	10000
HGXD1T" Reduced phosphor	Rescale 0.8	rescale ~6000-7500



- 1 on the graph means : 1 percent saturated per TW when MCP is 1280 mm from TCC
- I extrapolated saturation values to 100V using 3x/50 Volts as the gain factor
- Dashes are 3x/50V guidelines
- GXD1 may have changed (reduced) sensitivity sometime in 2012

- **Saturation levels are uncertain**

# Framing Camera Operational Issues

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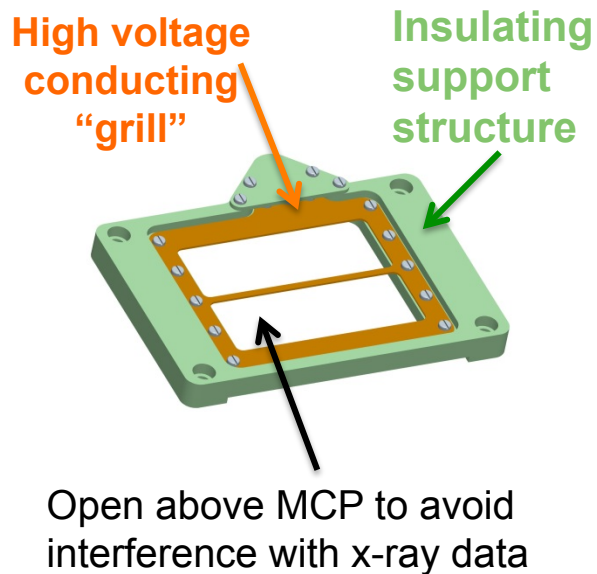
- **GXDs : strip 1 must be first**
  - Bias voltage minimum = 60V (no alarms)
  - Bias voltages can be set in increments of 10 V –
    - prefer users use 60,100,150,200 , 250V etc to “lump” calibration and FF efforts
  - Maximum interstrip delay = 50 ns, in units of 25 ps
- **HGXDs**
  - Strip 1 is not required to be first
    - Need to verify/calculate timing requests with TDOs/RSs –
      - most NIF software does not account for strip1 delay
  - Bias voltage minimum = 50V
  - Bias voltages can be set in increments of 50V
  - Maximum interstrip delay = 10.4 ns, in units of 25 ps (10400 ps)
- **HGXD1 has higher gain on strip 2 due to cross talk (gain variation reduced after 1/2015 reclamp)**
- **HGXD2F rebuilt head after October2015 has relatively slow strips fed by tapered transformers**
  - **Do not operate with interstrip timing < 250 ps**
  - Observed delays with 0/250/500/750 settings 0/250/514/743@ 200V
  - Strip length on film  $\sim 35\text{mm}/(0.132 \text{ mm /ps}) = \sim 265 \text{ ps}$
- **HGXD6F has relatively slow strips fed by tapered transformers**
  - showed strong cross talk effects in calibration at 0/200/400/600 set
    - observed (1/3.8/3.2/2.4 x) with measured delays 0/189/402/590
  - **Do not operate with interstrip timing < 250 ps**

# ERASER mitigates the effect of early x-rays

## ERASER Early Radiation Artifact Suppression Electrode Rig

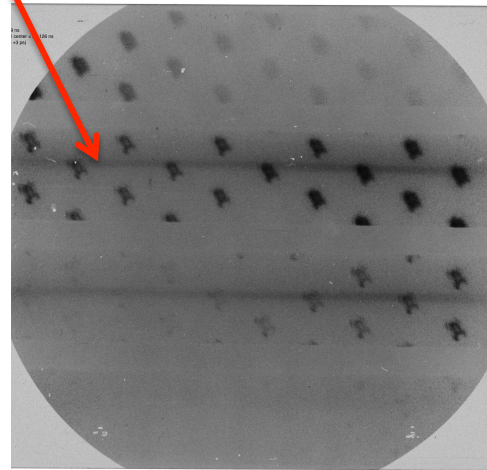
ERASER suppresses artifacts by attracting electrons before the camera is triggered.  
High-voltage surface installed ~1cm above framing camera active area (microstrips)  
Changes E-field to attract electrons that arrive before amplifying voltage

### ERASER Schematic



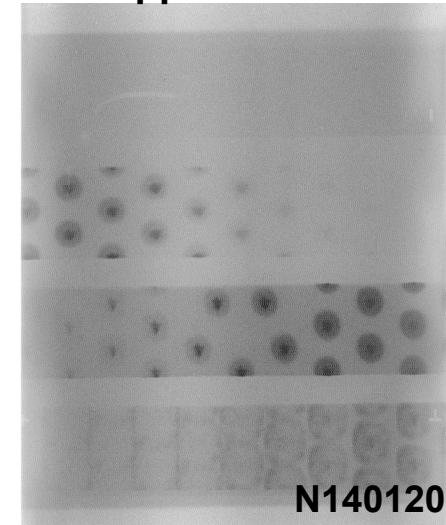
### HGX11 without ERASER

Artifacts due to x-rays that arrive before camera is triggered



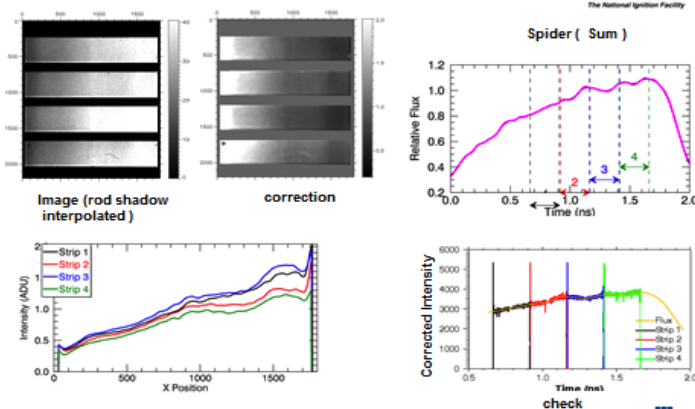
### HGXD2F with ERASER

No apparent artifacts



# Estimates at best 20% (normalization), for ~8keV x-rays Strip to Strip, Droop and dependence on Timing and bias details

HGXD2F Flatfield settings: 150V, 250ps consecutive spacing



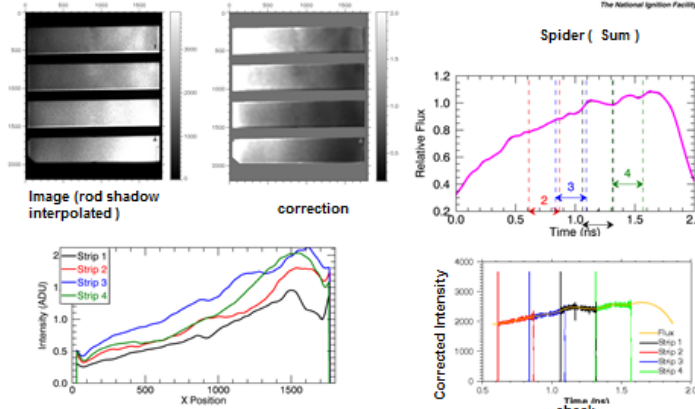
N160829-002 (S. Khan)

NIF Performance Review – Limited Distribution

10/28/2018



HGXD6F Flatfield settings: 150V, Con A 2314 timings



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To "1" of FF correction note strip to strip variation


 $HGXD2/HGXD6 \text{ raw} = (3300/2250) = 1.466$ 

Expected flux ratio  $= (1280/960)^2 = 1.778$ 
 $HGXD2/HGXD6 = 0.825$ 

HGXD2

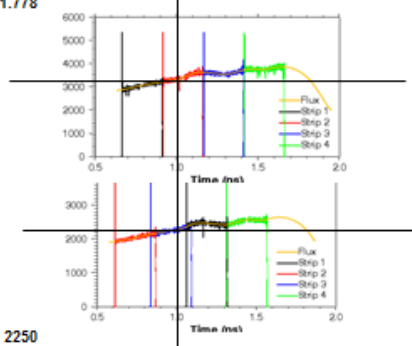
~960mm

3300

HGXD6

~1280mm

2250



Looking to “average correction” produced by FF correction ( looking at check graphs produced by Shahab) I Get that HGXD2 (sequential) is 0.825 of HGXD6F (Con A timing) on average... but looks like **strip to strip variations with particular timing larger**

N160829-002

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